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EERF (Eastern Environmental Radiation Facility) Standard Operating Procedures for Radon-222 Measurement Using Charcoal Canisters

(U.S.) Eastern Environmental Radiation Facility
Montgomery, AL

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16. ABSTRACT

This report describes in detail EPA's office of Radiation Programs Eastern Environmental Radiation Facility's standard operating procedures for radon - 222 measurement using charcoal canisters. It lists the materials and equipment that are used and explains their laboratory and survey methods.

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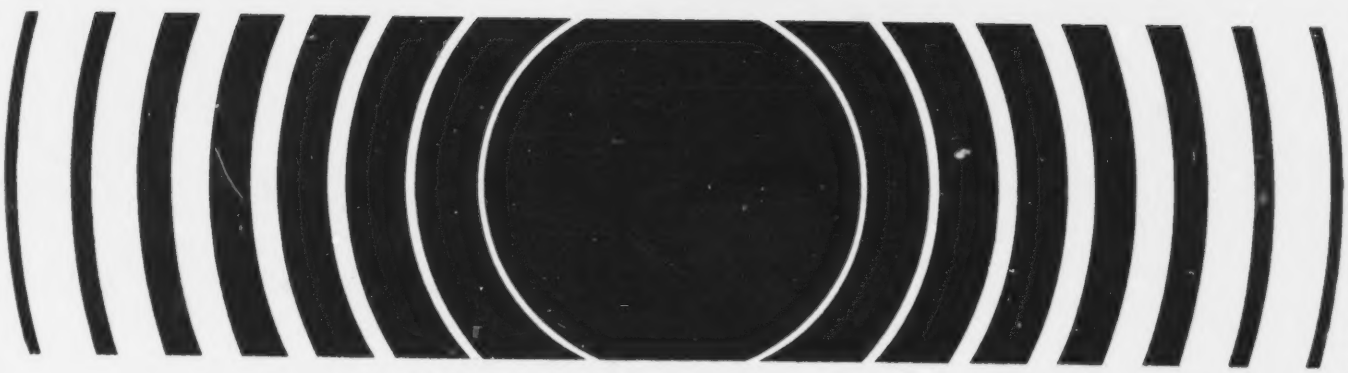

EPA 520/5-87-005

EERF STANDARD OPERATING PROCEDURES FOR RADON-222 MEASUREMENT USING CHARCOAL CANISTERS

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March 1987

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EERF Standard Operating Procedures for

Radon-222 Measurement Using Charcoal Canisters

I. Introduction

Activated charcoal has a large affinity for several gases and vapors including radon-222 (hereafter referred to as radon). Radon is sorbed onto the charcoal grains and decays to several particulate decay products: radium A (polonium-218); radium B (lead-214); radium C (bismuth-214); radium C' (polonium-214); and radium D (lead-210). Radon concentration is determined by counting the gamma ray emissions of both lead-214 (295 KeV and 352 KeV) and bismuth-214 (609 KeV). This is possible due to the relatively short half-life of these progeny. Within 3 hours the progeny are in equilibrium with radon-222.

The passive nature of activated charcoal allows both adsorption and desorption, and, in addition, the adsorbed radon undergoes radioactive decay during the exposure period. Therefore, the canister cannot uniformly integrate over the entire exposure period. However, the canisters can be calibrated to yield precise results for radon concentrations in structures during the deployment period of 48 hours used by the U.S. Environmental Protection Agency (EPA).

The charcoal adsorption method has been reviewed extensively by Cohen (Co83, Co86), Prichard (Pr85), and George (Ge84). The EPA's canister and analysis technique most closely resemble George's work, differing only in calibration aspects.

II. Materials and Equipment

A. Charcoal Canister

The passive radon charcoal canister used by the EPA consists of the following materials: (1) 8 ounce metal can with lid (4 inch diameter by 1 1/8 inch deep); (2) 70 $\pm$ 1 grams of 6 X 16 mesh activated charcoal; (3) metal screen, with an openness of at least 30 to 50 percent; (4) removable, internally expanding retaining ring; (5) pad material attached to the inner surface of the lid; and (6) a 13 inch strip of pliant vinyl tape. The materials are assembled as seen in Figure 1.

The activated charcoal must have low radioactivity content. Specifically, gamma emitters, except for natural potassium-40, must be less than 0.1 picocuries per gram.

B. Counting System

The following components make up the counting system used by the EPA's Eastern Environmental Radiation Facility: (1) 3" by 3" sodium-iodide detector and photomultiplier tube inside counting shield; (2) high voltage power supply; (3) pre-amplifier and amplifier; (4) single channel analyzer and scaler; (5) timer; (6) time of day clock; and (7) printer.

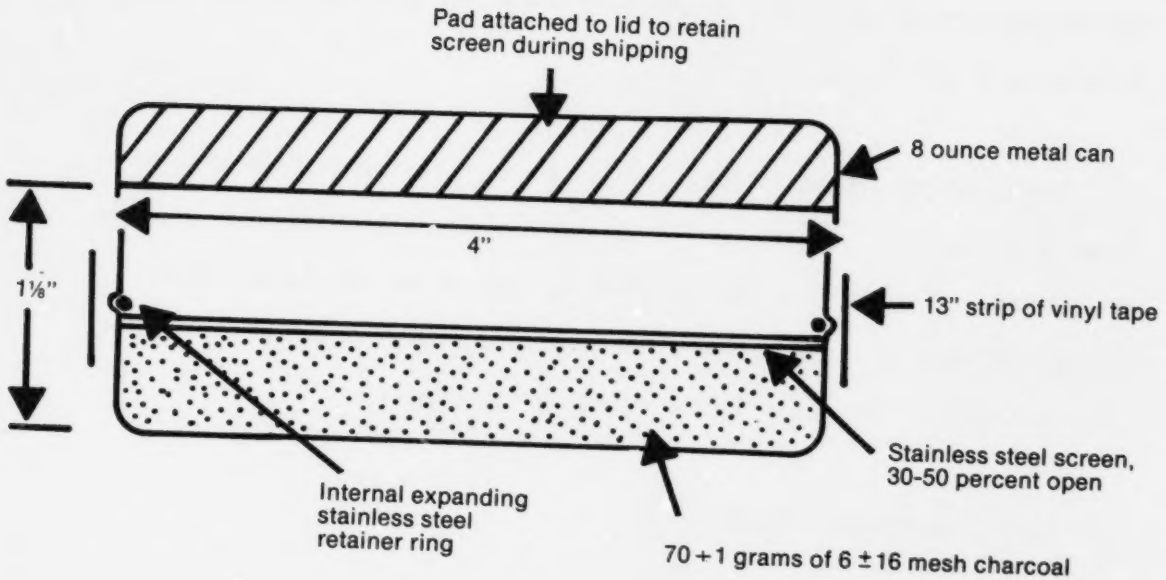

Pad attached to lid to retain screen during shipping
8 ounce metal can
4"
1⅛"
13" strip of vinyl tape
Stainless steel screen, 30-50 percent open
Internal expanding stainless steel retainer ring
70 + 1 grams of 6 ± 16 mesh charcoal

FIGURE 1
Charcoal canister assembly

Four sodium iodide detectors are served by a single high voltage power supply, timer, printer, and time of day clock. Each detector has its own pre-amplifier, amplifier-single channel analyzer, and scaler. The four detectors are arranged together inside a shield that has steel walls 8 inches thick. Within the shield the detectors are separated from each other by 4 inches of lead. A wooden jig is used on each detector to assure consistent counting geometry for the canisters on the detector. The arrangement of detectors in the shield and the electronics are shown in Figures 2 and 3.

The counting system is operated in the single channel mode with a lower discriminator setting of 270 KeV and an upper discriminator setting of 720 KeV. All counts in this region are summed during the counting period. A multi-channel analyzer is used once a week to assure there has been no shift of the peaks in the region of interest.

C. Radon Calibration Chamber

The EERF uses 2 radon calibration chambers to expose charcoal canisters and other instruments to known concentrations of radon and radon decay products in controlled environmental conditions. Radium-226 sources are used to provide radon which is continuously flowed through the chambers. In the chamber, controlled conditions include relative humidity (10 to 90 percent), temperature (0° to 40°C), condensation nuclei (10^3 to 10^6/ml), radon concentration (10 to 1,000 picocuries per liter (pCi/liter), and radon decay product concentration or working level (WL) (0.01 to 5 WL).

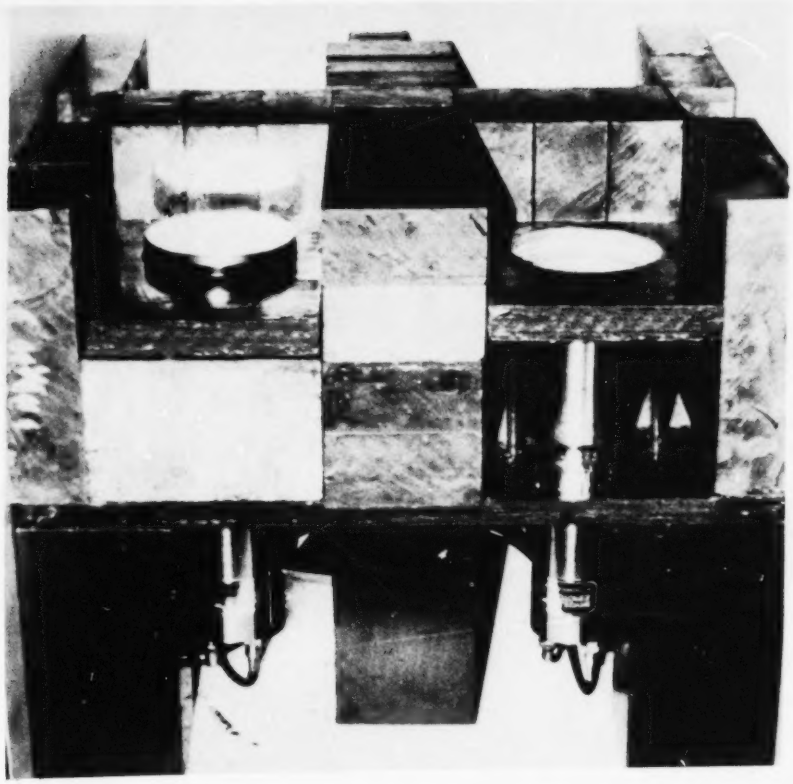


FIGURE 2
Four detectors in counting shield

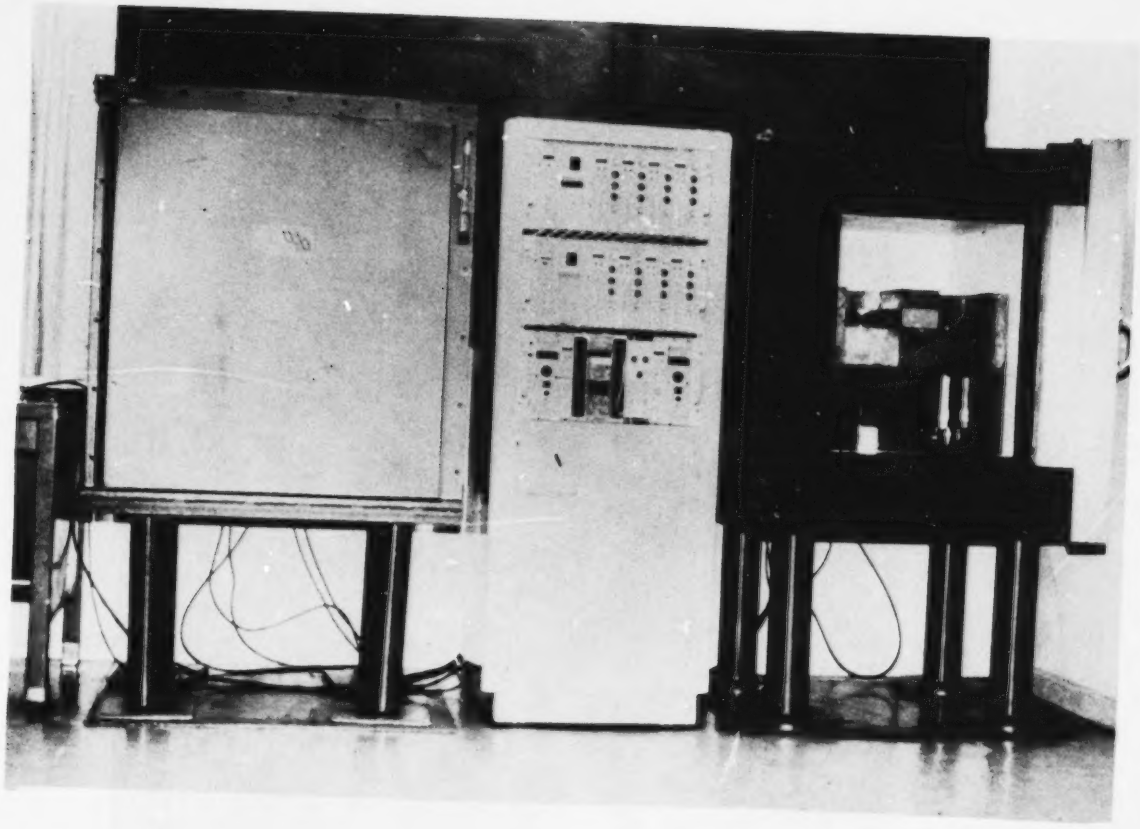


FIGURE 3
Two shields with electronics

The temperature, humidity, radon concentration, radon decay product concentration, and condensation nuclei concentration are monitored continuously and printed out each hour. Radon concentrations are monitored using a 0.5 liter flow through scintillation cell and decay product concentrations are monitored by counting, with a surface barrier detector, the alpha activity from decay products collected on a filter.

Grab samples in conjunction with the hourly printouts are used to determine radon and decay product concentrations in the chambers. The grab samples, which are done in conformance with recently published EPA procedures (EPA86), are used to calibrate the hourly printouts.

D. Standard and Background Canisters

Counting system performance is determined daily by counting standard canisters containing known radioactivity and background canisters. The standard canisters were made by the quality assurance group at the EERF in the following manner: (1) a known activity of about 20.5 nCi, liquid radium-226 was slurried into the 70 grams of charcoal in a canister with the retainer screen removed; (2) this was heated to dry all liquid from the charcoal; (3) the canister was sealed by soldering a galvinized metal disc in the can where the screen normally is located; (4) the lid was placed on the canister and secured with tape; and (5) the standard was stored for thirty days to allow secular equilibrium to be reached between the radium, the radon, and the progeny. Standard and background canisters were prepared for each crystal and are counted every morning to establish

a daily counting efficiency for each detector system. The counting efficiency is determined by counting the standard and background canisters each for 10 minutes. The background count is subtracted from the standard count to get the net count. This is divided by the time, 10 minutes, to get net counts per minute (CPM). By dividing the net CPM by the known activity (pCi) of the standard the efficiency (CPM/pCi) of the detector for that day is determined.

E. Scales

Digital scales are used to weigh individual canisters both before shipment to the user and upon receipt after exposure. This weight difference, which relates to moisture gain or humidity, is an integral part of the calculation of radon concentration and will be explained in greater detail in the next section. Canisters are weighed to 0.1 gram accuracy.

III. Laboratory Methods

A. Canister Preparation

Calibrations are run on representative samples of canisters from each new batch from a supplier. As required by the EPA purchase contract, the supplier identifies each batch by the color of the vinyl tape used to seal the lid. Gamma emitter content of the charocal is also checked for each batch to make sure no contaminated charcoal is being used.

Each canister is given an individual serial number. This number is printed on the data label attached to the top of each canister. Once this label is attached, the canister is weighed and the weight is written on the label and is automatically entered into the EERF computer for that respective canister serial number. The canister is now ready to use for calibration runs or in a home for a radon measurement.

B. Calibration

The response of charcoal canisters depends on the length of time the canister is exposed and on the amount of water gained during the exposure. This is because the charcoal has a strong tendency to adsorb water from air. For this reason the canister calibration is a two step process designed to adjust for both water gain and exposure time. The following steps are used to calibrate canisters:

1. Chamber Preparation

The charcoal canisters are calibrated to three humidity ranges (low, medium, and high) over a period of one to six days. Low, medium, and high humidity correspond approximately to 20, 50, and 80 percent humidity. The radon concentration in the chamber is kept as constant as possible during the three runs. The first step of this process, therefore, entails stabilizing the chamber at the desired condition.

2. Canister Exposure Sequence

When the chamber is stabilized, a set of 30 canisters is put into the chamber and exposed in the following manner: a group of five each for 1, 2, 3, 4, 5, and 6 days, respectively. The canisters are opened inside the chamber and the exact start times are recorded. This exposure sequence is repeated twice more, once at each of the other two humidities, to complete the calibration run.

3. Removal and Counting

At the end of each 1 day period specified above, a group of 5 canisters is removed for counting. The lids are placed on the canister while still inside the chamber and the canisters are removed, taped, and the exact time is recorded. The canisters are allowed to sit for at least 3 hours to allow progeny to equilibrate with the radon before counting.

Each canister is counted for ten minutes on a sodium-iodide detectors described previously. The count time and detector number are recorded so that the efficiency of that detector, from previous counting of standard and background, can be incorporated in the calculation of calibration factors. After counting, the canisters are weighed and the weight difference is recorded.

4. Calculation of Calibration Factors

A calibration factor is calculated for each canister using the following equation:

$$CF = \frac{\text{NET CPM}}{(T_S)\ (E)\ (RN)\ (DF)}, \qquad \text{(Equation 1) (Ge84)}$$

where

CF = Calibration factor, radon adsorption rate (l/min),

NET CPM = Gross CPM for that canister - background CPM for that detector for that day,

T_S = Exposure time of the canister (minutes),

E = Detector efficiency for the appropriate detector (CPM/pCi),

RN = Radon concentration in the chamber for the exposure period (pCi/liter),

DF = Decay factor from the midpoint of exposure to the time of counting, which is calculated from

$$DF = e^{-\frac{.693t}{T_{1/2}\ R_n\ (\text{min})}} \quad \text{or} \quad e^{-\frac{.693t}{5501\ \text{min}}},$$

where t = time in minutes from midpoint of exposure to the start of counting.

5. Generation of Calibration Curves

Calibration factors as derived from the equation above are used to generate two tables and two curves. The first table, Table 1, relates calibration factor to weight gain (water) for the canisters for a 2 day exposure, the time used by EPA for its surveys (see IV D). Data in this table are plotted to generate Figure 4. The second table, Table 2, relates exposure time to adjustment factors for 20, 50, and 80 percent humidity. The adjustment factor is used to modify the calibration factor for exposure times different from the desired 2 day exposure time. If a canister is exposed for exactly 2 days, the adjustment factor is 1. This is explained in more detail in III C 5. Data in this table are plotted to generate Figure 5.

Figures 4 and 5 are typical calibration data that were developed for a particular batch of canisters from a supplier. New calibration data are developed and used with each different lot of canisters.

C. Calculation of Radon in an Exposed Canister

Equation 1 above may be rearranged to solve for the radon concentration if the calibration factor is known. This equation will be

$$RN = \frac{\text{NET CPM}}{(T_S)\ (E)\ (CF)\ (DF)}\ , \qquad \text{(Equation 2)}$$

where

RN = Radon concentration in pCi/liter,

NET CPM = Gross CPM for the canister - background CPM for that detector for that day,

T_s = Canister exposure time (minutes),

E = Detector efficiency (CPM/pCi),

CF = Calibration factor, and

DF = Decay factor from the midpoint of exposure to the start of counting.

Table 1

Water Gain Versus Calibration Factors For a 2 Day Exposure

Percent Humidity	Water Gain (g)	CF (liter/min)
20	0.0	0.105
20	0.0	0.101
20	0.0	0.105
20	0.0	0.110
20	0.0	0.107
50	1.7	0.098
50	1.8	0.094
50	1.9	0.097
50	1.8	0.102
50	1.8	0.096
80	7.7	0.077
80	7.5	0.082
80	7.7	0.076
80	7.9	0.076
80	7.9	0.078

Table 2

Exposure Time Versus Adjustment Factors
for Low, Medium, and High Humidity

Time of Exposure (Hours)	Adjustment Factors (liter/min)		
	20 Percent	50 Percent	80 Percent
24	0.137	0.132	0.116
24	0.143	0.137	0.125
24	0.141	0.132	0.118
24	0.135	0.126	0.117
48	0.138	0.127	0.118
48	0.107	0.096	0.077
48	0.110	0.102	0.082
48	0.105	0.097	0.076
72	0.101	0.094	0.076
72	0.105	0.098	0.078
72	0.087	0.075	0.048
72	0.091	0.079	0.051
72	0.088	0.075	0.051
96	0.083	0.073	0.046
96	0.085	0.075	0.049
96	0.074	0.058	0.035
96	0.080	0.062	0.034
96	0.075	0.059	0.033
120	0.074	0.057	0.033
120	0.075	0.060	0.034
120	0.070	0.051	0.023
120	0.073	0.054	0.025
120	0.071	0.051	0.024
144	0.069	0.050	0.023
144	0.071	0.052	0.023
144	0.064	0.045	0.018
144	0.068	0.047	0.019
	0.064	0.047	0.016
	0.062	0.044	0.018

FIGURE 4. WATER GAIN VERSUS CALIBRATION FACTORS (CF) FOR A TWO DAY EXPOSURE

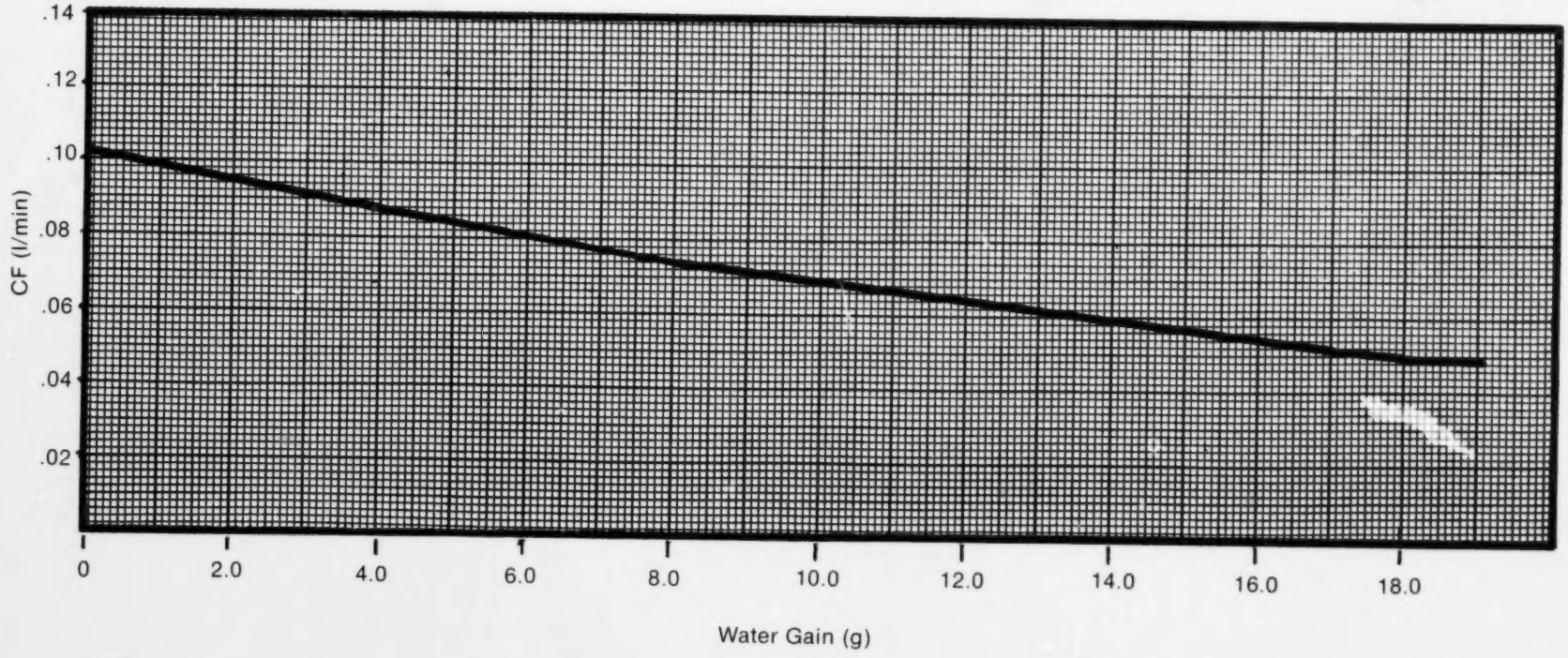
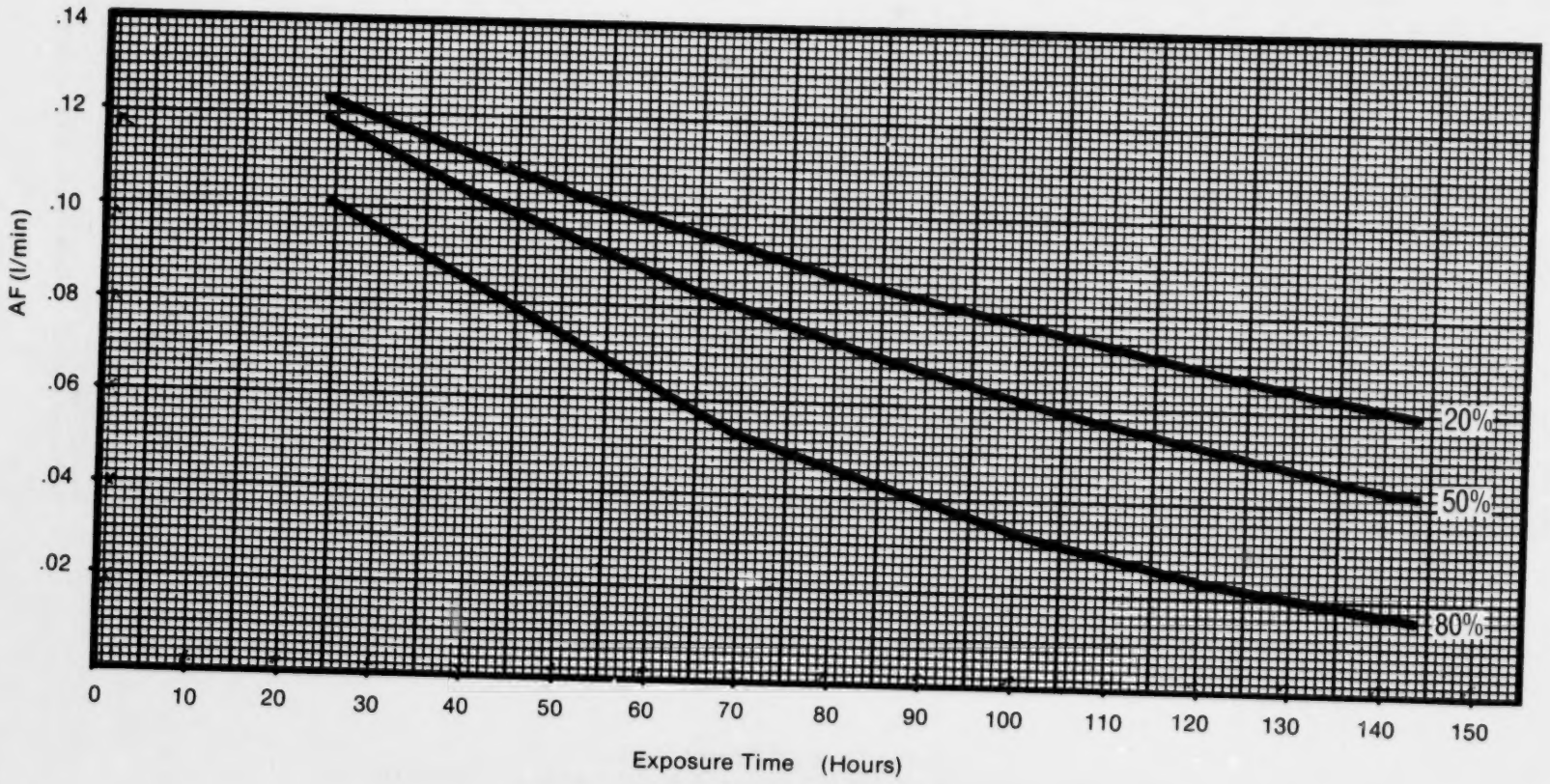


Figure 5. EXPOSURE TIME VERSUS ADJUSTMENT FACTORS (AF) FOR LOW, MEDIUM, AND HIGH HUMIDITY



The following steps are taken to analyze the canister and calculate the radon concentration to which a canister has been exposed:

1. Count the standard canister on the detector to be used. Calculate the efficiency (E) for that detector in CPM/pCi as in section II-D. This efficiency is used for all counting done on that detector for that day.

2. Count the background canister on the detector. This background count is used for all counting done on that detector for that day.

3. Weigh the canister to be analyzed. This weight gain in grams of water during the exposure period is referred to as (g) in Table 1 and Figure 4.

4. Use the water gain (g) on the X-axis on Figure 4 to obtain an initial CF from the Y-axis.

5. If an exposure period other than 48 hours was used, this initial CF must be adjusted to reflect the actual exposure time for the canister. This is done by using the water gain to select the appropriate humidity curve on Figure 5. The correct humidity curve is selected based on the following criteria:

If (g) is	Use Curve for
less than 1.0 g	20 percent
1.0 g to 4.0 g	50 percent
greater than 4.0 g	80 percent

Using the correct water gain on the X-axis and relative humidity curve on Figure 5, an adjustment factor (AF) is selected from the Y-axis and used to adjust the initial CF (obtained in step 4 above) for the exposure time. This is done as follows:

$$\text{Final CF used in Eq. 2} = \text{Initial CF} \times \frac{\text{AF for actual exposure time}}{\text{AF for 2 day (48 hr) exposure time}} .$$

From this it is seen that if the actual exposure time is 48 hours the AF becomes 1.0 and the initial CF is actually the CF used in Equation 2.

6. The decay factor (DF) is used to correct for radiological decay between exposure and counting. It is calculated from the midpoint of exposure to the start of counting using the formula

$$DF = e^{-\frac{.693t}{T_{1/2} \text{ for radon}}} ,$$

where t is the time from midpoint of exposure to the start of counting and $T_{1/2}$ is the half-life of radon.

EXAMPLE CALCULATION

To calculate the concentration of radon in a canister we use Equation 2,

$$RN = \frac{\text{NET CPM}}{(T_s)\ (E)\ (CF)\ (DF)} .$$

The data given for this example calculation are the following:

Weight Out = 158.7 g

Weight In = 161.1 g

Exposure Period = 12-29-86 at 1052 CST to
01-01-87 at 0950 CST

Gross Counts = 2,942 in 10 minutes

Background Counts = 721 in 10 minutes

Standard Counts = 58,423 in 10 minutes for a 20,549 pCi source

From these data, we first determine that

$$\text{Net CPM} = \frac{2{,}942 - 721}{10 \text{ min.}} = 222 \text{ CPM},$$

T_s = 70 hours, 58 minutes = 4258 minutes, and

$$E = \frac{(58{,}423 - 721)/10 \text{ minutes}}{20{,}549 \text{ pCi}} = 0.281 \text{ CPM/pCi}.$$

To determine the calibration factor (CF), we must refer to the equation

$$CF = \text{Initial CF} \times \frac{\text{AF for exposure time}}{\text{AF for 2 day (48 hours)}}$$

and use the weight gain in our calculations. In this example, the weight gain during exposure was 2.4 g (161.1 g - 158.7 g). From Figure 4, we find that the initial CF for 2.4 g = 0.094; and, according to Figure 5,

a 2.4 g weight gain requires the use of the curve for 50 percent humidity. Since a 2.4 g weight gain of 50 percent humidity results in an AF for the actual exposure time (~ 71 hours) of 0.080 and an AF for 48 hours of 0.098, the final CF is 0.077, as calculated by

$$\text{final CF} = 0.094 \times \frac{0.080}{0.098} = 0.077 .$$

The decay factor for Equation 2 is calculated by

$$DF = e^{-\frac{.693t}{T_{1/2} \text{ for radon}}},$$

where t = midpoint of exposure time to start of counting time,

$$= \frac{4,258}{2} + 4,312,$$

$$= 6,441 \text{ minutes},$$

and $T_{1/2}$ of radon = 3.82 days or 5,501 minutes. The decay factor then is calculated by

$$DF = e^{-\frac{(.693)\ (6,441)}{5,501}},$$

$$= 0.444.$$

The final radon concentration is calculated by substituting the above values into Equation 2 as follows:

$$RN = \frac{222}{(4258)\ (0.281)\ (0.077)\ (0.444)},$$

$$= 5.4 \text{ pCi/liter.}$$

The 2-sigma counting error is calculated as follows:

$$2\sigma \text{ error} = 2\ \frac{\sqrt{\text{Gross counts + Background Counts}}}{\text{Gross counts - Background Counts}},$$

$$2\sigma \text{ error} = 2\ \frac{\sqrt{2,942 + 721}}{2,942 - 721},$$

$$= .054,$$

$$= 5.4 \text{ percent.}$$

Therefore, the radon concentration was 5.4 pCi/liter $\pm$ 5.4 percent.

D. Calculation of Minimum Detectable Activity

The minimum detectable activity (MDA) for measuring radon using charcoal canisters is a function of the background counting rate of the counter system and the counting time (A163). The MDA at the 3-sigma significance level is given by

$$MDA = 3\ X\ \frac{\sqrt{\text{BKG Count}}}{\text{BKG Count Time}},$$

where

MDA = MDA as function of counts above background,

BKG Count = Total background counts, and

BKG Count Time = Counting time of background.

For the EERF counting system, this calculates as

$$\text{MDA (CPM)} = 3 \times \frac{\sqrt{750}}{10},$$

$$= 8.2 \text{ counts per minute.}$$

This may be converted to activity of radon in pCi/liter by assuming exposure conditions. For our desired exposure conditions, this calculates as follows:

Assumed conditions:

Exposure time = 2 days (48 hours)

Relative humidity = 50 percent (2 gram water gain)

Time in shipment = 3 days (4,320 minutes)

Counter efficiency = 0.28 CPM/pCi

MDA (CPM) = 8.2 (from above)

$$\text{MDA (pCi/liter)} = \frac{\text{MDA (CPM)}}{\text{(Exposure Time) (E) (CF) (DF)}}$$

$$= \frac{8.2}{(2{,}880)\ (0.28)\ (.098)\ (.48)}$$

$$= 0.22 \text{ pCi/liter}$$

Since assumed conditions are not always met, in EERF data reports the MDA is conservatively reported as less than 0.5 pCi/liter.

E. Quality Assurance Procedures

The EERF radon calibration chambers are the principal source of quality assurance exposures for charcoal canisters. After the initial calibration run on each new batch of canisters from a supplier, periodic checks are made on randomly selected canisters to assure no deviation.

Reliability of the EERF calibration chambers is assured through several programs. As described previously, the chamber is monitored continuously while in operation. Also, daily checks on the radon and radon decay product concentrations are made using grab sampling techniques. These same techniques are used by the EERF in national and international measurement cross-check programs. The EERF participates in these programs every time they are offered, usually several times per year. The EERF also sends groups of its canisters to operators of other radon calibration chambers for blind exposures as verification checks.

As part of the EERF's participation in the state radon survey program, we request that the participating states expose duplicate canisters and return them to the EERF for routine processing. This is usually done in 5 percent of the homes surveyed. The EERF also requests that the states submit blank canisters back to the EERF for analysis. These are sent in by each state at a rate of approximately 2 canisters per week.

The sodium iodide detectors and counting systems used for the analysis of canisters are calibrated daily using standard sources described in section II-D. The standard count for each detector system each day is entered into a computer maintained control chart (Ro65). If the daily standard count exceeds the 2 sigma variation of the average of all previous counts for that system, the system is not used for counting until the cause of the excessive variation is determined. The same type analysis is also performed daily for a background canister on each system.

In actual field use the coefficient of variation of a canister should not exceed 10 percent at a radon concentration of 4 pCi/liter or greater. This precision is monitored using duplicate canisters (EPA86).

IV. Survey Methods

A. Shipping of Canisters

Canisters are prepared for use as described in section III-A. After preparation they are individually boxed and the individual boxes are packed into a shipping case, usually 150 canisters per case. These are shipped to the users through normal commercial carriers. An individual canister in its box may be mailed to a user. Prepaid labels are used to ship the individual boxes to the user and a prepaid label is provided to return the canister from the user to the EERF. Each individual box has a gummed flap for sealing the box prior to shipment.

B. Deployment

The charcoal canisters should be used as directed in the Interim Indoor Radon and Radon Decay Product Measurement Protocols, EPA 520/1-86-04, April 1986. The protocols specify house conditions at the time of measurement, provide instructions on selecting the location in the house at which to make the measurement, and suggest how to interpretation of results. Copies of the Interim Indoor Radon and Radon Decay Product Measurement Protocol may be obtained by written request to either of the following addresses:

U.S. Environmental Protection Agency
Office of Radiation Programs (ANR-458)
401 M Street, S.W.
Washington, DC 20460

Eastern Environmental
Radiation Facility
1890 Federal Drive
Montgomery, AL 36109

Where to Place the Charcoal Canister

Please make sure that for 12 hours before and during the 2-day measurement period:

- Windows and external doors are kept closed, except for normal entry and exit,

- Fans or ventilation systems that use outside air, such as attic fans, are not operated.

If your house has a basement, place the canister anywhere in the basement, except in a garage, root cellar, or crawl space. If your house does not have a basement, place the canister in any room on the lowest floor of the house, except in a bathroom, kitchen, or porch.

Within the selected room, the canister should not be in a location frequently exposed to noticeable drafts of an open door, window, fireplace, etc. The canister should be exposed to air people breathe. It should be placed on a table or shelf at least 2 feet above the floor and should be in open air, not in a closet, drawer, cupboard, etc.

The canister should be opened and exposed to the air for 2 full days (48 hours) and then returned immediately for processing. Follow the PROCEDURE below for opening and resealing the charcoal canister. Do not open the canister to begin the measurement if you cannot end the measurement in 2 days.

PROCEDURE

1. Remove the tape from around the canister. Save the tape to reseal the canister at the end of the measurement.

2. Remove the lid from the canister. Place the lower half of the canister, with the screen side up toward the open air, on a table or shelf in the room chosen according to the above instructions.

3. Fill in the start date and time on the label on the canister lid.

4. After 2 full days (48 hours), replace the lid on the canister and reseal it with the tape.

5. Fill in the stop date and time on the label. This is very important. Also, please fill in the information requested (To Be Completed By Occupant) on the other side of this sheet.

6. Place the canister and this sheet in the box provided. Seal the box as shown below and place the addressed, postage-paid label on the box.

7. Mail the box within 1 day of resealing the canister. No postage is required.

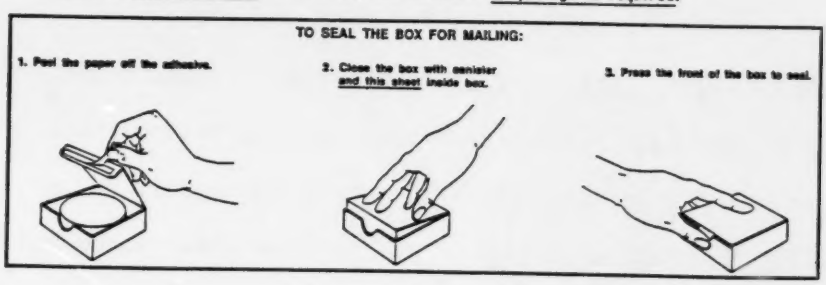

TO SEAL THE BOX FOR MAILING:
1. Peel the paper off the adhesive.
2. Close the box with canister and this sheet inside box.
3. Press the front of the box to seal.

FIGURE 6
Instruction sheet

C. Forms

A combination data-information form is shipped with each canister. The information side of the form contains detailed instructions for use and return of the canister. This form is shown in Figure 6. The other side of the form consists of blanks to be completed by the homeowner and the government agencies conducting the study. This data form is shown in Figure 7. Accurate and complete answers in the blanks are very important.

D. Time Restrictions

The following time restrictions, in regard to exposure time and the time in transit during return of the canister, are used in the EERF programs. The exposure time for the canister must not be less than 24 hours (1 day) nor longer than 144 hours (6 days). The desired exposure time is 48 hours (2 days). The time delay in returning the canister to the EERF for processing should be as short as possible to avoid excessive decay. All canisters received at the EERF are counted, regardless of the delay time. If the 3 sigma counting error is less than 100 percent, the results are calculated. If the 3 sigma counting error is greater than 100 percent, the canister is not calculated.

E. Reporting

Usually, all canisters received at the EERF are counted on the day they are received. The EERF reports results from canisters processed each two weeks. The report contains data for the canisters received during the

TO BE COMPLETED BY OCCUPANT

Date and time you started and stopped the measurement:

Start date ___/___/___ (m d yr) Time _____ ☐ AM ☐ PM Stop date ___/___/___ (m d yr) Time _____ ☐ AM ☐ PM

1. Postal zip code at location of measurement: _____.

2. Type of building in which measurement was made: ☐ single family home ☐ multi-family building ☐ business ☐ school ☐ other _____.

3. Floor of building where measurement was made: ☐ basement ☐ first floor ☐ second floor or above

4. Room in which measurement was made: ☐ bedroom ☐ family room ☐ living room ☐ unfinished basement ☐ office ☐ classroom ☐ other _____.

5. Were exterior doors and windows mostly open or closed during measurement? ☐ Mostly open ☐ Mostly closed

6. Comments: _____

_____.

FOR GOVERNMENT USE

House I.D. Code _____ Canister Number _____ (On canister label)

Geologic Region Code _____

EPA USE

Date Received ___/___/___ (m d yr) Date Counted ___/___/___ (m d yr) Time _____ ☐ AM ☐ PM

Detector Number _____ Gross Counts _____

Weight Out _____ Weight In _____

Counted by _____ Checked by _____

Entered by _____ Verified by _____

Comments: _____

_____.

FIGURE 7

Data form

previous two week period. Summary reports may be provided on request. The reports contain all the responses to questions on the data forms. If a form was not fully completed, this section will be blank on the report. Certain omissions, such as a start or stop date/time, make it impossible to calculate a radon value. The canister, however, is counted and the count data filed by canister serial number. If the missing data are supplied at a later date, the results will be calculated and reported on the next report. If any irregularities are noted in a canister, such as the top not taped properly, this will be noted in the comment section of the report. The responsible agency conducting the survey will be notified by telephone if any canister result is greater than 100 pCi/liter.

Agencies conducting surveys with the EERF canisters who have the appropriate computer equipment may access their data directly in the EERF computer. They will be given access only to their own data and will only be able to receive data from the EERF system. The EERF also can arrange to send data directly to agencies who have access to electronic mail. Interested persons should contact the EERF to arrange to get computer access or electronic mail.

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